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SCIENTIFIC APPROACHES TO THE STUDY OF THE HUMAN MIND[1]

By ARNOLD GESELL, M.D.

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WE are met to inaugurate a museum of psychology. May I begin by quoting a letter which I recently received from a spirited adolescent girl, age 14? "I have many hobbies," she wrote, "in fact they are almost countless. The one I like best is keeping a museum. As you probably remember, our house is quite large. My museum (the name of it is 'A Country Museum') is one of the smaller rooms upstairs. . . . Some of the things are Indian arrow heads, a tip of an Indian ax, a hornet's nest, and some butterflies. The thing that I thought would be interesting is to try to get a stone or two from every state of the union. . . ." So I sent her a rock from Connecticut.

[1] Address delivered at inauguration ceremony of Psychological Museum and First Psychological Exposition, Garfield Park, Chicago, May 4, 1938.

There is a good deal of psychology in that letter; not so much in the rock itself. A psychological museum must deal with phenomena less substantial and less accessible than rocks and hornet nests. Can it succeed in giving tangibleness to the human mind? The Lewis Institute, your trustees and director have undertaken a project of great difficulty, but one which has important pioneering possibilities. Museums have in general been devoted to the products and often to the curiosities of human culture. A psychological museum will have to concern itself in a new way with a delineation of the nature, mechanisms and the needs of human behavior. It will have to design a new kind of transparent man. Its problem is to objectify, to make visible, the operations and the laws of the human

mind, to give us an inside look. In this age of photography, of pictorial journalism and of the motion picture, of window displays and of murals, the race wishes to see with its own eyes, to look. More eagerly than ever, we are trying to get glimpses of ourselves.

Ancient man was moved by similar impulses. When he scratched and daubed his own murals of a bison hunt on the walls of a cave, he got a little further outside of himself and a better perspective upon himself. This was his art gallery and museum. But his psychology was crude. He had only the dimmest notion of his mental life and the mental life of others. He was confused by the echo in the valley, by the reflection of his own image on the water surface, by vapor and wind. He could not have understood William James's chapter on "The Stream of Consciousness," even if it had been translated into Neanderthal. (But even William James is rather recent, for it was only seventy years ago that he returned to America from Germany with tidings of a possible science of the mind.)

Savage man is to this day literally afraid of his own shadow. He regards his shadow as his very soul, or as a vital part of himself. The natives of Nias, Frazer tells us, tremble at the sight of a rainbow, because they think it is a net spread by a powerful spirit to catch their shadows.

Modern science has done something for us. It has at least explained the optics and the physics of the rainbow. And at long last, science is also removing some of the lingering terrors and mysteries of the human soul.

Psychology used to be defined as the science of the human soul. It makes little difference if we substitute the words human mind or human behavior. It is an error, however, to think of psychology as *the* science of the mind—as the one and only science of the mind. The organization of modern sciences is such that no one science can be allocated to a distinct and detached province. This is particularly true of the life sciences and their subdivisions. Only the dictionary maker can draw sharp cleavages to-day between physics, chemistry, biology, physiology and psychology. The whole trend of contemporary science is toward hyphenation and interpenetration. Johns Hopkins recently created a chair of physiological anatomy. Some time ago such a hybrid would have been regarded as grotesque. To-day we grant that static phenomena can be studied in the making. We also recognize that the most creative advances of science take place at the growing margins where diverse fields of science touch each other and lose their separate identities. The tendency toward excessive specialization is counterbalanced by a tendency toward hyphenation which brings disciplines into union. Witness psycho-biology, neuro-psychiatry, bio-physics, psycho-somatics, etc.

Paradoxically, the highest reaches in specialization require the profoundest fathoming into fundamentals. W. B. Hardy, for example, we are informed, started his career as a biologist but ended as a physicist, studying the phenomena of lubrication and the molecular structure of silk and wool fibers. Did he go astray? Not if we grant that the characteristics of protoplasm remain a mystery without a thorough knowledge of viscosity. We can not even be certain that he has not made an ultimate contribution to psychology, via the study of lubrication! Such round-about implication and deviousness of approach are in fact characteristic of the structure or rather the physiological anatomy of modern science.

Diverse sciences show a tendency to interpenetrate. This is peculiarly true of the study of the human mind. The psyche, the behavior of a man, is a focal manifestation of the "forces" of nature. Man is part of the order of nature, the same order which determines the differential elasticity of silk and wool fibers and the stripes of the rainbow. His psychology is an integrated expression of all the factors that contribute to the ordering of life. Neither the integration nor the factors can be comprehended by traveling the narrow trail of a single scientific discipline.

There are, accordingly, many scientific approaches to the problems of human psychology. I use the term approaches deliberately to suggest the broader avenues which lead to the central city of Man-Soul. The term is not necessarily synonymous with method. An approach is a pathway; a method is a manner of procedure by which you travel. Statistical method, for example, represents a tool, a mathematical device for the clarification and formulation of data rather than the creation of data. The experimental method, when it deals with crucial and predictive issues, is in many respects supreme. We are inclined to agree with Boring's contention that "the application of the experimental method to the problem of mind is the great outstanding event in the history of the study of the mind, an event to which no other is comparable."

It does not follow, however, that the science of the human mind has depended, or will depend, entirely upon direct experimentation with specific psychological phenomena. More than any other science, psychology will be derived from basic, contributive disciplines which deal with the subordinate but determining orders of nature. The science of psychology will continue to grow by a social process of accrual. It will advance on tidal currents generated by the basic sciences. Already it has burst the confines of a somewhat conventionalized series of text-books. At the moment we do not so much need a genius who will make original experimental discoveries in the realm of mind. Rather we need a Darwin who will reveal, coordinate and consolidate the unlabeled psychological knowledge

which has already accrued, but has not yet become intellectually integrated.

There are at least five fundamental approaches to the comprehensive science of the mind, and none of these is purely psychological. From a monistic standpoint of determinism, we need not insist too rigidly upon distinctions between mind and matter or between structure and function. We are obliged to reckon with all forms of relatedness which truly reflect the universal order and the regulatory principles that pervade alike animate and inanimate nature. Without aiming at symmetrical emphasis, our comments will deal with (1) Neurophysiology, (2) Chemistry, (3) Clinical Studies, (4) Developmental Morphology, (5) Cultural Anthropology. More direct and introspective approaches we shall not attempt to consider.

(1) *Neurophysiology.* Scientific psychology arose within the domain of physiology. Must it not always have a deep root in the physiology of the nervous system? For the nervous system supports and serves the fundamental functions of sensation and movement, which constitute the very essence of mind. To be sure you can not adequately "represent thoughts and emotions as nerve cells tickling one another." E. W. Scripture in a moment of autobiographic candor went on to say, "I throw aside every book on psychology the moment I see a picture of the brain in it." We can not, however, find support for this bit of Scripture in the writings of Sir Charles Bell, Johannes Müller, Magnus, Pavlov, Sherrington or Lashley.

Sechenov in 1863, in a famous lecture on "The Reflexes of the Brain," initiated a new chapter in science. "All psychical acts without exception," he boldly asserted, "if they are not complicated by elements of emotion, are developed by means of reflexes." From this thesis have sprung some 2,000 published studies of the conditioned reflex, with titles ranging from "The Withdrawal of the Tubeworm from a Shadow" to "The Investigatory Reflex of Homo Sapiens."

Neurophysiology is to-day one of the most active fields of hyphenated science. The techniques are becoming increasingly refined. A century and a quarter ago it was an epoch-making discovery to make a simple distinction between the sensory and motor roots of the spinal cord. To-day the almost infinitesimal currents of nerves and nerve centers are registered, their rhythms photographed in curves of beautiful precision. With devices for both auditory and visual magnification, the electrometry of the brain has swiftly amassed voluminous data—more in fact than the investigatory cerebrum can immediately cope with. By the method of thermo-coagulation, individual layers of the brain cortex are being separately explored. By means of ultra delicate probing, microscopic groups of nerve cells are being identified in the medulla. Such researches are destined to give us an intimate knowledge of the architecture of the nervous system, and this knowledge will make our concepts of human behavior more deterministic and mechanistic in the best scientific sense.

It can scarcely be argued that these neurophysiological studies lie too deep below the threshold of consciousness and outside the scope of psychology. Even in the detailed studies of animal respiration, it has been found that no two dogs breathe exactly alike. Individual differences in dogs and man must be studied on a neurophysiological level.

The work and the career of George E. Coghill furnish solid evidence of the scientific significance of the neurophysiological approach. His primary interest was psychological, but even as a graduate student he says, "I became aware that the natural approach to the kind of psychological information I wanted lay through the physiology of the nervous system. Obviously, also, the physiology of the nervous system must be approached through its anatomy, about which I knew nothing." So for thirty years or more he has been making minute studies of the genetic and functional histology of *amblystoma,* a mere mud puppy. Did he go astray?

Although Coghill has not made a single experiment in psychology, in the orthodox sense, he has already had a profound influence on the biological interpretation of psychological problems. His three lectures on "Anatomy and the Problem of Behavior," delivered in London, bid fair to become classic. The thin volume which contains them belongs on a five foot shelf.

(2) *Chemistry.* Chemistry is one domain of science which is certain to make epochal progress during the next few decades. And this progress, we may well believe, will reshape our concepts and control of human behavior. The Associated Press, in its report of the recent meeting of the American Chemical Society, characterized the newly purified protein prolactin as "this mother-instinct-crystal." Here we have hyphenation with a vengeance, but with more than journalistic justification, for it is literally true that this chemical substance releases, sustains and intensifies fundamental emotional reaction in different species equipped with mammary glands. (The newspaper headlines were startling enough: "Yale hormone makes tom cats give milk and roosters brood!")

Osler, in a more than humorous aside, while lecturing on endocrinology, told his audience that their ability to listen to his lecture depended upon the functioning at that very moment of their thyroid glands. These glands secrete thyroxine, a substance which is inextricably bound up with the phenomena of attention and memory, growth and learning. A universal his-

tory of psychology would have to give a place of honor to Kendall, who isolated thyroxine in 1918.

To illustrate the psychological implications, I may cite an illustration. For a period of twelve years we have followed the mental development of a girl who was diagnosed as a cretin in early infancy. She was fed thyroxine at the age of six months. She has attained a normal level of intelligence, thanks to the thyroxine which she has taken regularly all these years, with one exception. At the age of nine years temporary myxedema developed, due to a pharmaceutical error. The druggist having made a mistake, she was fed for one month on thymus rather than thyroid substance. Cretinous signs at once emerged, but retreated as soon as thyroxine was substituted. This child's psychology literally hangs on a thyroid thread, and in observing her we have acquired a healthy respect for the chemical basis of mental life.

The pharmacopoeia lists an amazing number of drugs which have psychological effects. Some day no doubt the mechanism of these effects will be better understood in terms of molecules, atoms, chemical mosaics and chemical configurations. Neurophysiological processes will be conceived chemically. Already they are being envisaged in terms of electrochemistry and the distribution of electric potentials.

The ordering factors of life are at bottom chemical, whether they be subatomic, atomic, molecular, colloidal, paracrystalline or anatomical. These chemical factors probably even determine the Gestalten of psychology. There is, in the words of Needham, "a hierarchical continuity." Biochemistry is increasingly concerned with the morphology as well as the constituency of matter, and is bridging the gulf between sciences of matter and of form. ". . . the fields of morphology and biochemistry are not so sundered as is often supposed. Organizing relations are found at the molecular level and at the colloidal and paracrystalline level, as well as at the anatomical level. Hardy's work, far from showing that no structure existed in the cell, showed on the contrary how subtle it must be. Although we are still in the earliest historical stages of any far reaching organization-calculus, we can yet see that biological order, like (but very much more complicated than) crystal order, is a natural consequence of the properties of matter, and one characteristic mode of their manifestation."

Needham should be able to speak with authority, for he has compiled three scholarly volumes entitled "Chemical Embryology." Is it not probable that some day we may have an equally monumental work on Chemical Psychology?

(3) *Clinical Studies.* Under this heading we wish to stress the importance of clinical materials and naturalistic data rather than the peculiar merits of clinical procedure. There is no occasion to make an invidious distinction between clinical and experimental methods. Each may reinforce the other. Healthy progress in experimental medicine depends upon corrective contacts with the realities of clinical medicine. The same interdependence holds for clinical and experimental forms of psychology.

There is a whole host of "experiments" which no scientist has the ingenuity to plan nor the gift to perform. Nature performs them and presents them to him as riddles to solve. They take the shape of monsters, of freaks, of abnormal, eccentric, atypical individuals. The anomalies and the deviations may involve the total organism, they may involve only a sector or a small phase. In such moments of abnormality, as Goethe once remarked, nature reveals her secrets. That is, she reveals them if we meet the challenge and make sufficient effort to explain her experimental vagary.

The feebleminded, the insane, the psychopathic, the genius, will always provide rich materials which can be encompassed only by expert familiarity, by a naturalistic feeling for reality and by intuitive insight. Let us not underrate the vast opportunities for productive interpretation. "It would seem," as Wilfred Trotter says in an acute article in the *British Medical Journal,* "that it must be an advantage to an experimental science to have an observational side, the function of which, in addition to its use as an implement of research, would chiefly be to promote the atmosphere of intellectual liveliness which is so important as evidence of health."

The unusual elucidates the usual, the abnormal helps to define the normal, because one is a variant or exaggeration of the other. There is one type of clinical material which furnishes extraordinary opportunity for controlled, comparative observation because it comes in pairs; namely, twins. Twins are interesting in their own right, but scientifically they are most significant when used as touchstones for the elucidation of biological and psychological phenomena.

The *method of co-twin control* is an experimental device for analyzing biogenetic problems, with special reference to mental growth, learning and individuality. Twins, particularly young monozygotic twins, are almost made to order for such biogenetic studies. In identical twins, nature provides a stage for comparatively observing the effects of a developmental stimulus which may be deliberately confined to one twin. By comprehensive cross reference, the co-twin becomes a control and a check both upon observation and conclusions. This method reaches its greatest efficiency when a high degree of correspondence has been established by careful measurements prior to the experimental observations. Careless use of the method and failure to define

thorough-going comparisons in advance should be deprecated.

The method has a certain statistical validity, even when confined to a single pair of twins. The "statistical" validity resides in the numerousness of the physical, biochemical and developmental correspondences which are so extensively present in monozygotic twins. The correspondences are sometimes so refined as to be little short of uncanny, as witness the exquisite similarities of twin electro-encephalograms. Where else in nature or in the samplings of the laboratory can we match in scope and detail the biological equivalence of identical twins?

From a research standpoint we need not unduly deplore the fact that quintuplets occur only once in 19,698,322 pregnancies. Twins we shall always have with us in ample numbers of highly similar pairs for clinical and experimental studies.

(4) *Developmental Morphology.* In the study of the human mind one can not escape problems of pattern and form. When Goethe coined the word *Morphologie,* he was interested in the forms of flowers and skulls. To this day the term carries physical connotations. But the concepts of morphology can be extended to the phenomena of behavior. Morphology is the science of form. Let the dictionary remind us that form is the shape of anything as distinguished from the substance of that thing. Behavior has shape.

The shapes which behaviors assume can be investigated in their own scientific right. A morphological approach leads to the description and measurement of specific forms; the systematic study of topographic relations and correlations of such forms, their ontogenetic progression and involution; their comparative features among individuals and among species.

"Structure is only the intimate expression of function," was a leading maxim of John Hunter. In a monistic (but not mystic) sense "the mind" may be regarded as a living, growing "structure," even though it lacks corporeal tangibility. It is a complex, organizing action system which manifests itself in characteristic forms of behavior—in patterns of posture, locomotion, prehension, manipulation, of perception, communication and social response. The action systems of embryo, fetus, infant and child undergo pattern changes which are so sequential that we may be certain that the patterning process is governed by mechanisms of form regulation—the same mechanisms which are being established by the science of embryology.

Experimental embryology is now one of the most active and flourishing of all the life sciences. It has undertaken the analysis of development, particularly as it affects the anatomy of the organism. But the investigators are increasingly using functional and behavior criteria to define the somatic anatomy. This is natural, for by the principle of hierarchical continuity, there is but one physiology of development. The growth of tissues, of organs and of behavior is obedient to identical laws of developmental morphology.

It can not, therefore, be doubted that the general physiology of mental development will find its deeper roots in the same scientific soil which is now intensively cultivated in laboratories of experimental embryology. Already many of the current morphogenetic concepts have more than vague analogy to psychical processes: embryonic field, gradient theory, regional determination, autonomous induction, complementary induction, potency, polarity, symmetry, time correlation, etc. Associationism as a psychological tradition has come down from Aristotle and still has considerable vitality, as shown by a prodigious preoccupation with problems of learning and the conditioned reflex. The laws of association deal with the factors of contiguity, assimilation, frequency, primacy, intensity, duration, context, acquaintance, maturity. Needless to say, these laws will some day be reformulated in terms of the biology and physiology of development. The full coordination of animal and human psychology will depend upon such reformulations.

A more concrete paragraph may be in order here. Take for illustration the tonic neck reflex (t.n.r.), an interesting, asymmetric pattern of behavior common to man and lower animals. Magnus discovered that when he rotated the head of an experimental rabbit, a characteristic response occurred: (a) extension of the forelimb on the side toward which the head was turned, (b) flexion of the opposite forelimb. We have found this postural attitude a ubiquitous characteristic of the human infant in the first three months of life. It is his preferred posture, as he lies supine, awake, head averted. By the age of 20 weeks, his head prefers the midline, his arms assume symmetric positions and frequently meet above his chest. The human t.n.r. is not a stereotyped reflex, but a growing pattern changing with the maturity and the economy of the organism. It involves far-reaching elaborations in eye-hand coordination, prehension, prone locomotion, laterality. It displays significant individual differences in motor demeanor and psycho-motor constitution.

This behavior form, which has essential counterparts in quadrupeds, exemplifies both the bonds and the cleavages between human and animal psychology. It may also suggest the validity of a broad morphological approach to the study of the human mind. In spite of an enormous descriptive literature, one might legitimately hold that human psychology is deficient in fundamental description, because it has not reckoned systematically with the form characteristics of

behavior. We lack the grammar and the lexicon for formulating these form characteristics. We must develop morphographic methods which will simplify and generalize form phenomena. A psycho-morphological approach will also bring us closer to the ancient problem of psychic constitution and of mental types. It is indispensable for the delineation of the ontogenesis of human behavior and the comparative psychology of life cycles.

(5) *Cultural Anthropology.* Hamlet must not be left out of the play. In fact, in the Story of the Human Mind, there are two Hamlets: the Biological Adam and Culture! Culture, as Malinowski aptly put it, is nothing but the organized behavior of man. The scientific study of the patterning of human culture would seem to constitute a fundamental approach to the science of the individual mind, which mind is in part a product, in part a creator, of the culture in which it has its being. Culture is "a large-scale molding matrix, a gigantic conditioning apparatus. In each generation it produces its type of individual. In each generation it is in turn reshaped by its carriers."

We are quoting Malinowski, for he is no mean authority and he grew up in the tradition of the exact sciences, including laboratory training in physical chemistry and experimental psychology at the University of Leipzig. As the founder of the functional school of anthropology, he holds that there exist scientific laws of culture. "Culture is a determinant of human behavior, and culture as a dynamic reality is also subject to determinism."

The term culture comprises much. It includes the prosaics of food getting and of everyday family life, as well as the exoticisms of ceremony and magic. It is not assumed that multifarious masses of anthropological data must be incorporated into the subject-matter of psychology. However, the anthropologist sees in living cultures, in spite of their apparent diversity, a pervading sameness, arising out of common traits of human nature. This quality of sameness denotes underlying psychological laws which should enable us to better understand ourselves and our cultures, including religion, morals, mores and government. Thus also we may arrive at more insight into the diseases of culture as manifested in poverty, economic crises, crime and war. It is not strange that cultural anthropology claims to be the very basis of social science. But scientific anthropology, no less than psychology, is inextricably bound up with physics, chemistry, physiology and biology. Culture began with a very primitive man who has not lost all his primitiveness.

The understanding of the human mind, it therefore seems, will be attained not through the researches of a single discipline, but through the conjunctive results of a great interlocking system of sciences, a system which is itself the most characteristic cultural product of our technological civilization. No previous culture has ever achieved a product more magnificent than the present body of natural and engineering science. This achievement is our hope, as well as our despair. The despair will not lessen until the techniques of modern science can be more sincerely brought to bear on problems of behavior. Only through profound self-knowledge can the human mind bring itself nearer to individual and collective control.

THE AMERICAN MATHEMATICAL SOCIETY
1888–1938

By Professor **ALBERT E. MEDER, JR.**
NEW JERSEY COLLEGE FOR WOMEN

IT is indeed strange that organized mathematics in America is only fifty years old, especially in view of the fact that mathematics is as old as civilization itself and that in Europe the seventeenth and eighteenth centuries were periods of tremendous mathematical advance. On this continent, however, even a half century ago there was but little mathematical research. To be sure, contributions to the science had been made by Robert Adrain, Nathaniel Bowditch and Benjamin Peirce of an earlier generation and by G. W. Hill, Simon Newcomb and Josiah Willard Gibbs among contemporaries, the *American Journal of Mathematics* was in its tenth year, a few universities had been sending out doctors in mathematics for some little time, and a number of Americans had received degrees from European universities, yet this activity was scattered and somewhat sporadic, and there was little cooperation or feeling of solidarity among American mathematicians. The time was ripe, however, for the formation of an organization to draw together those Americans interested in mathematical pursuits, and to foster actively the development of mathematical scholarship and research in this country.

It was not, however, the well-known mathematicians who took the initiative in forming such an organization. A young college instructor in his first year of service, Dr. Thomas Scott Fiske, of Columbia College, but recently returned from a period of study in Cam-

bridge, at which time he had attended meetings of the London Mathematical Society, thought, as he put it, that there should be "a stronger feeling of comradeship among those interested in mathematics," and proposed to two of his friends the formation of a similar society in New York. So it happened that three young men of twenty-three signed the call for the organization meeting, to which six persons responded and completed the organization of the New York Mathematical Society. J. H. Van Amringe, professor of mathematics at Columbia, was chosen president, and Fiske secretary, an office he held for seven years.[1]

The 6 increased to 16 by the end of 1889, to 23 in 1890, then, following a campaign for members directed by the secretary, to 210 at the end of 1891. In 1920 it was 770, and at the end of 1937, 2,127.

In 1891 the monthly publication, *Bulletin of the New York Mathematical Society,* was begun as "a historical and critical review of mathematical science" under the editorship of Professor Fiske, who established high standards in the development of what was essentially a new type of mathematical journal.

Three years later the society began the custom of holding summer meetings, and with the inauguration of this series changed its name to American Mathematical Society as a more accurate description of its constituency. Valuable as these summer meetings proved to be, with their larger attendance, wider geographic distribution and longer duration than the regular winter meetings, there was a further need which the society could satisfy. The suggestion came from Professor H. S. White in these words: "a series of three to six lectures . . . on selected chapters . . . bringing some fundamentals, but progressing also to some few of the highest and latest results of research." The society council was favorable; the name Colloquium was adopted for this activity, and in 1896 the colloquia were initiated in connection with the summer meeting of that year, the lecturers being Maxime Bôcher, of Harvard, and James Pierpont, of Yale. There were thirteen in attendance. Since that time there have been nineteen additional colloquia, and the attendance has reached a high point of 220. It is now the policy of the society to publish the Colloquium lectures, as well as to include in the series of Colloquium publications other monographs expository of new mathematical developments, even though these have not been orally presented. Twenty-four volumes in this series have been issued, and it is no exaggeration to say that they are internationally recognized as authoritative and distinguished presentations.

[1] It should be mentioned that the organization meeting and over two hundred later meetings were held in the halls of Columbia University, which has also provided the society's office and housed its library. For this hospitality, the society is truly grateful.

By this time the society's membership was so large (275) and so scattered that the meetings in New York and the summer meeting were inadequate properly to serve the membership. In 1897 there was therefore organized the Chicago Section, which continued an extremely active and productive existence until 1924, when its meetings became regular meetings of the society. The sectional organization was later extended to the western group, constituting the San Francisco Section, 1902–1929, and the Southwestern Section, 1906–1928. All meetings of the society in any section of the country are now regular meetings of the organization as a whole.

By 1898 the society began to feel the need of a journal for the publication of original mathematical research. Negotiations were begun with the Johns Hopkins University looking toward a cooperative arrangement with the *American Journal of Mathematics* whereby it would be enlarged and published jointly by the university and the society, the latter bearing the additional expense. The editorial control was to be vested in the society. These negotiations were not successful, and the society proceeded to consider the advisability of establishing its own journal. Once again Professor Fiske was the leader in making the arrangements. The younger men were all agreed as to the desirability of the step, but some of the older men feared that the establishment of such a journal would constitute a rival or competitor of the *American Journal of Mathematics,* and this would be both unfriendly toward the older publication and unfortunate in itself. The title *Transactions of the American Mathematical Society* was chosen to overcome these objections, for all were agreed that any society might publish its transactions without unfriendly inference. Professors E. H. Moore, E. W. Brown and T. S. Fiske were the first editors of the new periodical, which first appeared in 1900, and, as was true in the case of the *Bulletin,* they succeeded in establishing notable standards. Moore was editor-in-chief, and to him belongs primarily the credit for this achievement.

During its earlier years the society was the only American mathematical organization of national scope. Consequently its attention was necessarily given to matters of mathematical interest, but not of a research nature, such as college entrance requirements in mathematics, questions of pedagogy, etc. In 1914 determination of whether the society should continue its interest on all levels of mathematical activity or confine itself exclusively to the promotion of research was necessitated by the raising of the question of the relation of the society to the collegiate field covered by the *American Mathematical Monthly.* Early in 1915 the council of the society decided that "it is deemed unwise for the American Mathematical Society to enter into

the activities of [this] special field . . . but the Council desires to express its realization of the importance of the work in this field and its value to mathematical science, and to say that should an organization be formed to deal specifically with this work, the Society would entertain toward such an organization only feelings of hearty good will and encouragement." The next year the Mathematical Association of America was founded, and the good-will predicted by the council was immediately realized. The society and the association regularly hold their meetings on successive days in the same location, and joint sessions are frequent.

In recent years, there has been little fundamental change in the manner in which the society performs its functions. There may be mentioned the establishment in 1923 of the semi-popular Josiah Willard Gibbs lectureship on applied mathematics, this notable series of fourteen lectures being inaugurated in 1924 by the late Professor M. I. Pupin, an early member of the society; the holding of over two hundred invited "hour addresses" since 1921, largely on topics of current research interest; the provision of wider international contacts by means of reciprocity agreements—the first in 1922—with foreign mathematical societies for members of one of the societies to enter the other at reduced rates; the appointment, at the request of the *Annals of Mathematics* in 1926 and of the newly established *Duke Mathematical Journal* in 1935, of associate editors representing the society on the editorial boards of these independent journals; the consummation in 1927 of an agreement with the *American Journal of Mathematics* similar to that sought in 1898, thereby providing additional publication facilities sorely needed; the incorporation of the society under the laws of the District of Columbia in 1923, enabling it better to deal with its manifold financial problem; the extensive growth and increased usefulness of the society's library—particularly strong in relatively obscure journals—especially under the administration of Librarians D. E. Smith (1902–1920) and R. C. Archibald (1921–); the adoption in 1926 of the visiting lectureship plan, by which lectures by a distinguished mathematician are made available at a number of mathematical centers; and the establishment and periodical award of the Bôcher and Cole prizes for mathematical research.

Since 1891 the society has received and expended for society purposes over half a million dollars, well over half of this being derived from membership fees, and much more than three quarters having been spent for publication. In 1891, the year in which publication was first undertaken, the receipts were not quite $975 and the disbursements a little over $700; at present receipts and disbursements are each in the neighborhood of $35,000 per annum. Although the membership has increased tenfold, the expenses have multiplied fiftyfold. The greatest problem of the society through the years has been financial. In its solution, the society has always turned first to its members, who have helped notably in voting from time to time to increase their dues, in contributing to an endowment fund (now amounting to $70,000), in increasing the subscription list of the society's publications and in bringing new members into the society. A plan for patron and sustaining memberships was drawn up, which worked well during years of business prosperity, but failed under the stress of the depression: many of the sustaining memberships were held by commercial companies. The Carnegie Foundation, the General Education Board and the Rockefeller Foundation also helped generously by contributions and subventions. The present source of support beyond individual memberships and subscriptions is in institutional members—largely universities and research institutions—whose dues are calculated in proportion to the annual publications of the members of their staffs in the society's journals.

It is obvious that the transformation of a small local group into a national organization internationally recognized has been accomplished through devoted service; it did not just happen. The society has been especially fortunate in its secretaries: the work of Professor Fiske, the first secretary, has already been mentioned, and it is impossible to overestimate or exaggerate the importance of the zeal, wisdom and unceasing labor of the second secretary, Professor Frank Nelson Cole, of Columbia University, who served from 1895 to 1920. The present secretary, Dean R. G. D. Richardson, of Brown University, who has held office since 1921, and his associates, are worthy successors. The presidents, too, who, with one exception, held office for two years each, have been an able and honored group. Emory McClintock, G. W. Hill, Simon Newcomb and R. S. Woodward, who constitute the succession from 1891 to 1900, all were widely honored outside the circle of their own colleagues. E. H. Moore, Maxime Bôcher, H. B. Fine, E. W. Brown and Frank Morley—to mention among their successors only those no longer living—have likewise been of recognized eminence.

The future, as the past, of the American Mathematical Society depends on the men it will rally to its service. Signs are not wanting that men of talent and devotion are still to be found in its ranks. The society enters its second half century with the strength of a loyal membership, and the inspiration of a noble history—the development of a recognized "American School" of mathematics. Its accomplishments constitute as well a great responsibility. May it prove worthy of its heritage and promise.

OBITUARY

FRED CAMPBELL MEIER

FRED CAMPBELL MEIER, a passenger on the Hawaii Clipper, lost near the Philippines on July 28, was born in Riggston, Ill., on April 5, 1893. His father, W. H. D. Meier, rural schoolmaster and superintendent of schools, moved the family to Framingham, Mass., in 1910, took up work at Harvard and obtained his Ph.D. in 1919. It was only natural, perhaps, that the son should also go to Harvard and that the three daughters in this remarkable family should also go in for advanced academic degrees. Father, son and three daughters are all in the sixth edition of "American Men of Science."

After graduation from Harvard, he served as Austin teaching fellow there for two years, being awarded an A.M. in 1917. In 1918 he was offered a position in the Bureau of Plant Industry, U. S. Department of Agriculture, as assistant pathologist. In about a year he was transferred to the Bureau of Agricultural Economics as pathologist, returning to Plant Industry in 1921. In 1922 he was chosen as extension pathologist of the Office of Cooperative Extension Work investigating diseases of cucurbits. He held this position for eight years. It took him up and down the east coast, from the melon field to the market place. In 1930 the Division of Barberry Eradication was formed, and he was placed in charge. He left this position, however, in 1934 and returned to the Extension Service, which position he held at the time of his death.

From 1929 to 1934 he was secretary-treasurer of the American Phytopathological Society and business manager of its publication, *Phytopathology*. Because of his long association with this society and his extensive travels, he became well acquainted with plant disease control problems throughout the United States. He was a fellow in the American Association for the Advancement of Science, and a member of the Cosmos Club, Torch Club and Botanical Society in Washington.

In addition to his work on plant disease control, Meier will be remembered for his work on his hobby, aerobiology. He was intensely interested in the microbial content of the upper air, spending his own money and his vacations devising apparatus, making collections, photographing slides and studying cultures. He showed an uncanny aptitude in making contacts. Commercial airplane officials, as well as the Army and Navy, cooperated with him and made collections possible from the upper air, not only over land, but along the Atlantic coast and over the Caribbean Sea as well. He persuaded Colonel Lindbergh to aid him in designing a "sky-hook," by which samples of spores in the air were collected by the Lindberghs on their trip to Europe across the North Atlantic. Later Amelia Earhart took his apparatus and was making collections for him on her ill-fated round-the-world flight. This was a severe blow, but it did not discourage him.

As a result of his continued efforts, an Interdivisional Committee in the Life Sciences and the Division of Biology and Agriculture of the National Research Council was appointed in 1937, and Meier was named as chairman. Within a year he had obtained a grant from the National Research Council and the Bureau of Plant Industry, which would enable him to take leave from his official duties in the Extension Service and give two months in the summer of 1938 and four months in the spring of 1939 to this project. Thus at the beginning of the realization of the results of years of thought and effort, when he was really in a position to devote his best efforts to his hobby, his life was suddenly brought to a close. If it had to be, this was a most fitting manner for him to die, engaged in the work he liked best, pioneering in a field that has hardly been touched.

In 1920 he married Agnes W. Eastman, who survives him. He will be missed by a large group of friends, both official and social, who will long remember his unbounded energy and enthusiasm in work or play.

NATHAN R. SMITH

BUREAU OF PLANT INDUSTRY

RECENT DEATHS AND MEMORIALS

VICTOR KING CHESNUT, who had been connected until his retirement in 1933 for thirty-nine years successively as botanist and chemist with the U. S. Department of Agriculture, died on August 29 at the age of seventy-one years.

STUART A. STEPHENSON, professor of mathematics and engineering at Rutgers University, died on September 1 at the age of sixty years.

DR. THOMAS R. BOGGS, associate professor of clinical medicine in the Johns Hopkins University Medical School and physician in chief of the Baltimore City Hospital, died on September 2 in his sixty-third year.

DR. ARTHUR EVERETT AUSTIN, emeritus professor of the theory and practice of medicine at the Medical School of Tufts College, Boston, died on August 22 at the age of seventy-seven years. Dr. Austin specialized in diseases of the digestive tract.

DR. JOHN N. LOWE, associate professor of biology at the Northern State Teachers College at Marquette, Mich., died on July 27 in his fifty-second year.

SIR DAVID WILKIE, since 1924 professor of surgery at the University of Edinburgh, died on August 25. He was fifty-six years old. Sir David was known for research in abdominal surgery.

THE Board of Control of the Michigan College of Mining and Technology has officially named the mining building Sperr Hall in honor of the late Frederick William Sperr, head of the department of mining and civil engineering from 1894 to 1926. Professor Sperr died in November, 1929. The building now named in his memory was designed, erected and equipped under his supervision.

SCIENTIFIC EVENTS

THE PROPOSED DIVERSION OF THE WATERS OF YELLOWSTONE LAKE

PROFESSOR L. G. ROMELL, of Djursholm, secretary of the Swedish Government Committee on Planning and Recreation, who was at one time head of the department of forest soils at Cornell University, recently addressed a letter to Secretary Harold L. Ickes protesting against attempts made in the seventy-fifth Congress to permit diversion of the waters of the Yellowstone Lake for irrigation purposes in the Upper Snake River basin, Idaho.

Professor Romell wrote: "It may not be the business of anybody outside the United States to express himself on the proposed engineering and water diversion project in the heart of the world's oldest national park. However, in a way, the wonderland of Yellowstone belongs to the world. If commercial interests should be allowed to encroach upon Yellowstone Lake it would mean far more than despoliation and would be a terrific blow to the entire national park idea which could not fail to have its repercussions throughout the world."

In reply Secretary Ickes wrote in part:

I have received your letter of June 24, describing the damaging effects upon national park standards throughout the world that would follow if Congress were to authorize the diversion of waters of Yellowstone Lake for irrigation purposes, proposed in S. 3925 and H. R. 10469, introduced but not acted upon in the last session of the Congress.

It is gratifying to hear from you that Yellowstone National Park is taken as the international model for all national parks. It will be my endeavor to keep it so by opposing the present irrigation project and all proposals tending to break down the integrity of our national park standards. The enjoyment of its magnificent natural wonders is not limited to Americans. Last year alone some 6,400 visitors from 37 foreign countries visited the park.

Recalling that the Congress, in establishing the park in 1872, made it the duty of the Secretary of the Interior to provide "for the preservation, from injury or spoliation, of all timber, mineral deposits, natural curiosities, or wonders within said park, and their retention in the natural condition," Mr. Ickes said: "Like my predecessors I insist that this condition is indispensable if the Yellowstone National Park is to continue to fulfill the purpose for which it was established."

CHANGES OF PERSONNEL IN THE FOOD AND DRUG ADMINISTRATION

A NUMBER of changes have been made in the personnel of the Food and Drug Administration, of which Dr. W. G. Campbell is chief. These are:

Joseph Callaway, Jr., now chief chemist of the Eastern Food and Drug Inspection District, with headquarters at New York, becomes senior chemist to serve as technical assistant and secretary of the reorganized Food Standards Committee of four state food law enforcement officials and two members of the Food and Drug Administration. This committee will consider data on the authentic composition of food materials and formulate standards of identity and reasonable standards of quality and fill of container for various foods.

Roy S. Pruitt, now chief chemist of the New Orleans Food and Drug Inspection Station, also will be transferred to Washington and attached to the office of the chief to handle administrative details of the new cosmetic section of the law.

Dan Dahle, at present associate chemist in the Food Division of the Food and Drug Administration in Washington, who has had long experience in the development of food methods, has been assigned to develop laboratory methods for the analysis of cosmetics and will work in close cooperation with Mr. Pruitt.

Dr. J. J. Durrett, now chief of the Drug Division of the administration in Washington, becomes principal technical adviser and is attached to the office of the chief of the administration. He will share with other officers the responsibility of determining administrative questions on the application of the new law to drugs, devices, special dietary products and cosmetics, and will give special consideration to the adequacy of information submitted by manufacturers with their applications on new drugs filed in compliance with the provisions of the act.

Dr. Theodore G. Klumpp, now senior medical officer of the Drug Division, succeeds Dr. Durrett as chief of that division. Dr. Klumpp is a graduate of Princeton University, received his medical degree at Harvard Medical School in 1928, served his interneship at Peter Bent Brigham Hospital in Boston, was assistant resident physician at Lakeside Hospital, Cleveland, Ohio, instructor at Yale University Medical School, and an associate physician at the New Haven Hospital.

FOOD STANDARDS COMMITTEE OF THE FOOD AND DRUG ADMINISTRATION

SECRETARY OF AGRICULTURE HENRY A. WALLACE has approved the recommendation of the Food and Drug Administration for the appointment in that organization of a Food Standards Committee, which will func-

tion under the terms of the Food, Drug and Cosmetic Act of June 25, 1938.

It is the intention of the Food and Drug Administration to perpetuate the food standards committee which has functioned in promulgating administrative standards for the last twenty-five years. This committee has consisted of representatives from the Association of Official Agricultural Chemists, the Association of Dairy, Food and Drug Officials of the United States and the U. S. Department of Agriculture. Members of the committee are:

For the Association of Official Agricultural Chemists: C. D. Howard, director and chief, Division of Chemistry and Sanitation, State Board of Health, Concord, N. H.; Guy G. Frary, state chemist, Vermilion, S. D.

For the Association of Dairy, Food and Drug Officials of the United States: J. J. Taylor, state chemist, Department of Agriculture, Tallahassee, Florida; Mrs. F. C. Dugan, director, Bureau of Foods, Drugs and Hotels, State Board of Health, Louisville, Ky.

For the Food and Drug Administration: W. B. White, chief, Food Division; W. S. Frisbie, chief, Division of State Cooperation.

The work of the committee will be to formulate definitions and standards both of identity and of quality, including fill of container, after consideration of all the data—analytical and inspectional—deemed essential to support them. The committee will meet in the Food and Drug Administration at Washington at intervals to review the data which have been assembled, draft tentative standards, and then upon the conclusion of public hearings, required by the act, make its final recommendations. Under the new act these definitions and standards when promulgated by the Secretary will have the full force and effect of law.

The first committee to consider food standards was one appointed by the Association of Official Agricultural Chemists in 1897. This committee was originally headed by Dr. Harvey W. Wiley. By virtue of the congressional appropriation act of June 3, 1902, the Department of Agriculture was authorized to investigate food standards and the Association of Official Agricultural Chemists committee was named for this purpose. This committee was supplemented in 1905 by the appointment of a representative of the Association of Dairy, Food and Drug Officials. The tripartite form of the committee was established as the result of a general conference between State and Federal food and drug officials held in November, 1913.

THE AMERICAN CONGRESS ON OBSTETRICS AND GYNECOLOGY

THE first American Congress devoted to a consideration of medical, nursing and other problems associated with human reproduction will be held in Cleveland, Ohio, from September 11 to 15, 1939, inclusive. It will be designated the American Congress on Obstetrics and Gynecology. The promotion and sponsorship of the congress has been delegated to the American Committee on Maternal Welfare, which includes the following organizations in its membership:

American Association of Obstetricians, Gynecologists and Abdominal Surgeons.
American College of Surgeons.
American Gynecological Society.
American Hospital Association.
American Nurses Association.
American Protestant Hospital Association.
American Medical Association, Section on Obstetrics and Gynecology.
American Public Health Association.
Central Association of Obstetricians and Gynecologists.
Chicago Maternity Center.
Maternity Center Association of New York.
National Medical Association.
National League of Nursing.
National Organization for Public Health Nursing.
New England Obstetrical and Gynecological Society.
Pacific Coast Society of Obstetrics and Gynecology.
Southern Medical Association.
U. S. Bureau of the Census.
U. S. Children's Bureau.
U. S. Public Health Service.

The purpose of the congress is to afford opportunities for discussing and publicizing the problems associated with human reproduction and the health of women and new-born babies. The value of more generally disseminated knowledge about the processes and problems of human reproduction and of the special diseases of the female generative organs and of the new-born is important in the maintenance of public health and therefore the interest of woman's welfare extends not only to the medical profession but to associated groups, including nurses, public health officials, hospital administrators, eugenists and many others.

The last International Congress of Obstetrics and Gynecology was held in Amsterdam in May of the present year. Its success stimulated a desire to hold a subsequent one in five years in another European country. It is felt that the difficulties associated with an international assembly, such as languages, expense, long distance travel and limited participation, lack of common interest, call for a regional gathering in which opportunities for more general discussions would prevail. The proposed American congress will therefore be modeled on different lines and includes participation not only by medical groups but by those devoted, as already stated, to nursing, public health and institutional administration.

In addition to the scientific sessions it is planned to provide for several evening meetings at which speak-

ers of prominence will discuss the broader aspects of the subjects for the lay public. There will also be prepared a comprehensive exhibit—scientific, educational, technical and commercial.

Members of the executive committee are: Fred L. Adair, Chicago, *general chairman;* Robert D. Mussey, Rochester, Minnesota, *vice-chairman;* Sara B. Place, Chicago, *secretary;* Rudolph W. Holmes, Chicago, *treasurer,* and Frederick H. Falls, Chicago, *assistant treasurer.*

National, sectional and local specialist societies have approved the congress and have made contributions for its support. It is desired that a wider representation be secured through the medium of contributing memberships, the cost of which has been placed at five dollars. Application may be made at the office of the congress at 650 Rush Street, Chicago, Illinois.

SYMPOSIUM TO COMMEMORATE THE CENTENARY OF THE CELL THEORY

IT has been decided to hold a symposium at the Richmond meeting of the American Association for the Advancement of Science, Sections L, G and F collaborating, to commemorate the centenary of the cell theory. The major lines of this symposium have been determined as follows:

a. Four to six papers are to be presented by men of sound judgment and thorough knowledge of the facts, so that the symposium may represent an outstanding contribution to the history of the subject.

b. Biographical accounts are to be limited though not omitted; a broader base than the work of Schleiden and Schwann alone will be looked for in developing the foundations of the theory (by including the work of such a man as Purkinje); and stress will be laid upon what the cell theory is to-day.

The program for this symposium is in process of being developed by the chairmen and secretaries of sections F, G and L and by other officers of the association. At the same time, it has seemed desirable to appeal through the pages of SCIENCE to all scholars who may be interested in the symposium for further suggestions, particularly for the names of outstanding men who might be invited to participate.

The Mexican Society of Natural History is offering awards for the best scientific papers celebrating the centenary of the foundation of the cellular theory and will publish a commemorative volume. Papers presented in the symposium of the American Association for the Advancement of Science in Richmond can presumably be submitted for these awards also, and for a place in the commemorative volume, if that seems desired.

Please send suggestions either to the permanent secretary of the association or to the undersigned, Dr. Joseph Mayer, Secretary of Section L, Library of Congress, Washington, D. C. JOSEPH MAYER

SCIENTIFIC NOTES AND NEWS

SIR ALBERT SEWARD, from 1906 to 1936 professor of botany at the University of Cambridge, was elected president of the British Association for the Advancement of Science at the Cambridge meeting. Sir Albert was master of Downing College, Cambridge, from 1915 to 1936, and was vice-chancellor of the university from 1924 to 1926. Two members of the council were elected, Dr. Charles E. Spearman, emeritus professor of psychology at the University of London, and Dr. C. R. Fay, reader in economic history at the University of Cambridge. The meeting in 1939 will be held at Dundee. The places of meeting for 1940, 1941 and 1942 will be Newcastle, Belfast and Birmingham.

DR. MAJOR GREENWOOD, professor of epidemiology and vital statistics at the School of Hygiene and Tropical Medicine of the University of London, has been awarded the Bisset Hawkins Gold Medal of the Royal College of Physicians for his researches in statistics.

Nature reports that the joint committee of representatives of the Royal Society of Edinburgh, the Royal Physical Society and the Royal Scottish Geographical Society has awarded the Bruce Memorial Prize (1938) to Alexander R. Glen for his work in Spitsbergen, including survey in New Friesland and the completion of the map of North East Land. The council of the Royal Society of Edinburgh has awarded the David Anderson-Berry Prize (1938) to Miss Mary A. C. Cowell, of the Holt Radium Institute, Manchester, for her essay entitled "An Investigation into some of the Factors affecting the Response of Human Skin and Human Skin Tumours to Radiation."

AT the annual dinner on August 31 of the San Francisco meeting of the American Society of Bacteriologists Dr. Jerome T. Syverton, assistant professor of bacteriology at the University of Rochester, in recognition of his work on filterable viruses, was presented with the prize of $1,000 and a medal, founded by Eli Lilly and Company. The award is given annually to an investigator under thirty-one years of age who has made outstanding contributions to knowledge in the fields of bacteriology and immunology.

DR. WALLACE E. HERRELL, of the Mayo Foundation, has received the first award of the Foundation Prize of the Association of Obstetricians, Gynecologists and Abdominal Surgeons. His paper, entitled "Studies of

the endometrium in association with the normal menstrual cycle, with ovarian dysfunctions and with cancer of the uterus," will be presented on September 24 at the fifty-first annual meeting of the society at White Sulphur Springs, W. Va.

PROFESSOR ALFRED REHDER, of the Arnold Arboretum, Harvard University, celebrated his seventy-fifth birthday on September 4. In appreciation of his conspicuous services over a period of forty years to horticulture, dendrology, systematic botany and botanical bibliography, the staff tendered a dinner to him and to Mrs. Rehder on the evening of September 1. During the course of the dinner, Professor Rehder was presented with a substantial purse provided by members of the committee appointed by the Corporation of Harvard University to visit the Arnold Arboretum and by his associates.

DR. WALTER ANDREW BLOEDORN, assistant dean of the School of Medicine of the George Washington University and medical director of the university hospital, has been appointed acting dean of the School of Medicine.

DR. CHARLES E. PALM, assistant professor of entomology at Cornell University, has been appointed head of the department of entomology to succeed Professor O. A. Johannsen, who retired on July 1.

THE REV. DR. HILARY JURICA, professor of biology at St. Procopius College, Lisle, Ill., has been appointed head of the department of biology at DePaul University, Chicago, beginning in June, 1939. Until then he will be consulting head *in absentia,* and Professor F. A. Varrelman will be acting head of the department.

DR. EARLE B. PERKINS, professor of zoology and Antarctic explorer, has been appointed head of a newly established department of biophotography at Rutgers University. The department will continue on an enlarged scale the photographic research of the late Norman McClintock, photo-naturalist, who died early this year. The directional functions of the University Committee on Photographic Research in Biology will be taken over by Dr. Perkins. The department will undertake the production of instructional motion pictures of college grade in the field of biology and related subjects (botany, surgery, medicine, veterinary science and psychology), and the use of the motion picture camera as a research tool in the analysis of biological problems.

DR. CHILTON A. WRIGHT, of Washington, D. C., has been appointed professor of sanitary and hydraulic engineering at the Polytechnic Institute, Brooklyn, N. Y.

DR. RUSSELL H. LYDDANE has been appointed assistant professor of physics in the University of North Carolina. He will take the place of Professor Otto Stuhlman, Jr., while the latter is on sabbatical leave. Dr. J. B. Fisk has been appointed associate professor.

DR. ROMAN KENK, extraordinary professor of zoology at the University of Ljubljana, Yugoslavia, has been appointed associate professor at the department of biology of the University of Puerto Rico.

THE Paris correspondent of the *Journal* of the American Medical Association reports that Professor Fernand Bezançon, phthisiologist, and Professor Marion, urologist, of the University of Paris, retired at the close of the academic year. In their case the law which now requires the retirement of university professors at the age of sixty-five years was modified so that they would not be obliged to retire until they had reached the age of seventy years.

THE Buhl Foundation grant for research in biochemistry has been renewed for the college year 1938–39 for studies on vitamin C, tissue respiration and molecular structure in the department of chemistry of the University of Pittsburgh. The following are the appointees under the renewed grant: Research fellows: Max O. Schultze, Ph.D., Wisconsin, animal nutrition and tissue respiration; Rade R. Musulin, Ph.D., Pittsburgh, animal nutrition, and Herbert E. Longenecker, Ph.D., Pennsylvania State College, the molecular structure of fats. Research assistants: Carter J. Harrer, B.S., Pittsburgh, tissue respiration; Theodore H. Clarke, B.S. Chem., Pittsburgh, the molecular structure of fats and sugars; Mary L. Dodds, B.S. Chem. and M.S., Pittsburgh, tissue respiration. The work on heats of combustion in relation to molecular structure will be under the supervision of Dr. Gebhard Stegeman, professor of physical chemistry. Dr. Charles Glen King, professor of biological chemistry, is director of the general project.

PROFESSOR H. J. CHANNON, professor of biochemistry at the University of Liverpool, has been appointed by the British Secretary of State for the Colonies member of a commission to visit the Malay Straits to survey existing arrangements for higher education, general and professional.

DR. MALCOLM H. SOULE, professor of bacteriology and director of the Laboratory of Hygiene of the University of Michigan, secretary of the Section of the Medical Sciences of the American Association for the Advancement of Science, has been appointed a delegate from the association to the Malaria Congress to be held in Amsterdam from September 23 to October 1.

PROFESSOR W. K. GREGORY, curator of comparative anatomy at the American Museum of Natural History and professor of paleontology at Columbia Uni-

versity, accompanied by Dr. Milo Hellman, professor of dentistry at the university, arrived in New York from South Africa on September 3. The visit was made at the request of Dr. Robert Broom, curator of anthropology at the Pretoria Museum, and Professor Raymond Dart, of Witwatersrand University, Johannesburg. Studies were made of the fossil skulls of anthropoid apes found in South Africa.

DR. WILBUR A. SAWYER, director of the International Health Division of the Rockefeller Foundation, left on September 2 for Bogota, Colombia, where he represented the United States and the Rockefeller Foundation at the Pan-American Sanitary Conference, which opened on September 4. Dr. Sawyer made the entire trip by air.

DR. WALTMAN WALTERS, professor of surgery at the Mayo Foundation, left Rochester, Minn., for a visit to Europe on September 4. He plans to read a paper before the meeting of the International Society of Surgery, which will be held in Brussels from September 19 to 22. He will also speak at the meeting of the French Urological Congress in Paris, which is being held from October 6 to 8. Later Dr. Walters will spend about three weeks in Great Britain, returning to the Mayo Clinic on November 7.

DR. ELLIOTT P. JOSLIN, emeritus professor of clinical medicine at the Harvard Medical School, delivered the two Malthe lectures and conducted a clinic in Oslo on September 5, 6 and 7; he will participate in a symposium on protamine insulin with Dr. H. C. Hagedorn, of Copenhagen, and Dr. Wilhelm Falta, of Vienna, before the Gesellschaft für Verdauungs- und Stoffwechsel-Krankheiten in Stuttgart on September 23.

The Collecting Net reports that Dr. Gregory Clarke, of Harvard University and the Woods Hole Oceanographic Institution, has leave of absence from the institution for three months to study the techniques used in fresh water lakes with a view to determining their application to marine conditions. Dr. Clark is now with Dr. Juday, who is director of the Trout Lake Limnological Laboratory in Wisconsin.

THE Australian and New Zealand Association for the Advancement of Science announces that H. G. Wells; Sir John Flett, until his retirement in 1935 director of the Geological Survey of Great Britain and of the Museum of Practical Geology, London; F. T. Brooks, professor of botany at the University of Cambridge, and Dr. Nevil Vincent Sidgwick, professor of chemistry at the University of Oxford, have accepted invitations to attend the meeting in Canberra next January.

DR. H. W. GILLETT, metallurgist at the Battelle Memorial Institute, Columbus, Ohio, will deliver the 1939 Howe Memorial Lecture of the American Institute of Mining and Metallurgical Engineers.

ACCORDING to *Nature* the Polish journal *Acta Astronomica,* in its July issue, states that the following members of the staff of the Pulkovo Observatory have been imprisoned: I. A. Balanovsky, N. I. Dneprovsky, B. P. Gerasimovič (director), P. I. Iaschnoff, B. W. Noumeroff (director of the Astronomical Institute at Leningrad, who is believed to have been shot) and N. W. Zimmermann.

EXAMINATIONS are announced by the U. S. Civil Service Commission for vacancies in the various government departments in the field of physics. Examples of positions known to exist at the present time are: Principal physicist (high voltage therapeutic equipment), National Institute of Health, Treasury Department; associate physicist (electro-acoustics), Bureau of Mines, Department of the Interior, College Park, Md; and associate biochemist (radiation), Division of Industrial Hygiene, National Institute of Health, Treasury Department, Washington, D. C. There is a vacancy in the Bureau of Mines at Pittsburgh in the position of mineral economist. The salaries attached to these positions are as follows: Principal physicist, $5,600 a year; senior physicist, $4,600; physicist, $3,800; associate physicist, $3,200; assistant physicist, $2,600; junior physicist, $2,000; mineral economist (non-ferrous secondary metals), $3,800.

THE annual meeting of the American Society of Zoologists will be held in Richmond, Va., on December 28, 29 and 30. All sessions for the reading of papers and for demonstrations will be held at the Medical College of Virginia, which is centrally located in Richmond. Members of the society, who wish to present papers at the Richmond meeting, should send titles and abstracts to E. G. Butler, secretary, Princeton University, on or before November 1.

THE twenty-sixth annual meeting of the American Association of Cereal Chemists will be held in Kansas City, Mo., from May 15 to 19, 1939. The association, which was organized in Kansas City in 1914, last met there in 1929. It is composed of chemists in the milling, baking, brewing and allied industries. The president for the current year is Dr. W. F. Geddes, of the Canadian Grain Research Laboratory, Winnipeg.

THE summer meeting of the Plant Taxonomists of the Indiana Academy of Science opened at Bass Lake, Indiana, on September 2 and lasted for four days. Field trips were made to various lakes and other points of interest to botanists in the northwest part of the state. The plant taxonomists of the Michigan Academy of Science were invited guests at the meeting.

DISCUSSION

ISOLATION OF URACIL FROM LIVER

IN the course of a fractionation procedure designed for the isolation of one of the water-soluble vitamins from liver extract, a crystalline compound was obtained which was identified as uracil. Because we have been unable to find a report of the presence of free uracil in liver and because of the rather unusual, yet simple method that yielded the pure material, it may be of use to other workers to record our observations briefly.

A commercial alcohol-soluble fraction of pork liver extract obtained as a by-product in the preparation of the pernicious anemia factor was used as a starting material.[1] This sirup was dissolved in water, concentrated under reduced pressure, adjusted to a pH between 6 and 7, and extracted continuously with ether for 75 hours. A pale yellow, crystalline deposit slowly formed in the boiling flask during this time. These crystals were filtered off and recrystallized from water. The resulting white product gave a strong test for uracil when treated with bromine water and barium hydroxide, and contained 25.3 per cent. nitrogen (calculated for uracil, 25.1 per cent.). The phenylhydrazine derivative prepared according to Levene's directions[2] melted at 250°; 5-phenylhydrazine-uracil melts at 252°. The yield amounted to 0.007 per cent. of the fresh liver.

These facts leave no doubt as to the presence of uracil in the liver extract. However, it may be possible that the pyrimidine was an artifact, and that it arose from cytosine during preparation of the extract. Since enzyme action is rapid, artifacts may conceivably arise even in the relatively short time required to make an aqueous extract of the organ.

Similar procedures applied to rice bran extract have resulted in the isolation of uracil from this material also.

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FACETTED PEBBLES IN EASTERN VENEZUELA

IN the southwest part of the state of Anzoategui, in eastern Venezuela, there are extensive areas of rolling savanna land, covered by coarse grass and a thin growth of scrubby trees; with the drainage courses marked by narrow bands of dense tree growth. The surface is composed of late Tertiary sand and clay; and over much of the area there is a sprinkling of pebbles, concentrated by erosion as a lag gravel from some of the sandy beds. Nearly all these pebbles are of quartz, well-rounded; with occasional less-rounded fragments of chert. The greater number range from about one-half inch to two inches in greatest dimension.

Scattered among these rounded pebbles there are also facetted pebbles of quartz, with rarely a facetted chert pebble. Many are well-formed dreikanters, with triangular cross section and lens-shaped sides. Occasional pebbles, oval in general shape, have only one well-developed edge. A greater number of pebbles show only partial facetting. Their frequency varies considerably in different localities, perhaps having been governed by favorable exposure to the prevailing wind. A rough analysis of groups of 200 pebbles, gathered from eight widely separated localities, is given in Table I.

TABLE I

Locality	A	B	C	D	E	F	G	H
Good specimens	0	1	2	2	2	3	5	12
Partially facetted	1	5	3	4	8	4	24	22
Some facetting	4	8	5	10	22	9	28	31
Not appreciably facetted.	195	186	190	184	168	184	143	135

The two localities showing greatest frequency of facetting are on opposite sides of the valley of the Aribi River, on upland benches; the other localities are at places on the savanna lands not especially exposed to the wind.

Since they were facetted most of the pebbles have acquired a rust-colored film from the sandy soil. Some on stream terraces are clear white, but their edges are somewhat rounded, as if they had undergone partial re-rounding since being facetted.

In many places the surficial material has been cemented by iron oxide into hard sandstone and conglomerate; which, by differential erosion, now cap low mounds, knolls and even hills, rising above the mean level of the savanna lands. The pebbles in the conglomerate are so like those of the lag gravel that it seems probable they all have a common origin.

In a few places where blocks of the conglomerate are exposed to winds from the east or southeast, the surface pebbles have been polished, and even worn into curved surfaces; but an unsuccessful search was made for facetted pebbles embedded in the conglomerate. It would seem, therefore, that the conglomerate was formed prior to the period of facetting, and also in some places underwent sand-blasting.

[1] We wish to thank Dr. David Klein of the Wilson Laboratories for generous gifts of this material.

[2] P. A. Levene, *Jour. Biol. Chem.*, 63: 658, 1925.

The region now has a mean annual rainfall in excess of fifty inches, and is not subject to high winds carrying sand. It seems probable that the facetted pebbles indicate a former period of aridity which occurred after the lag gravel was formed, perhaps sometime during the Quaternary period.

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ISOTOPES OF URANIUM AND LEAD

THE *Science News Letter* item on Dr. Nier's work[1] in its headlines at least rather ignores the preceding work, preliminary to Dr. Nier's brilliant papers. That "lead atoms may yield clues to very old earth's history" and that in ordinary uranium there are two kinds of atoms with different atomic weight, yielding leads of different atomic weights, was argued by T. R. Wilkins as far back as 1926,[2] and, as he suggested, then in early days there would have been not merely more uranium, but a larger proportion of the more quickly decaying uranium isotope—actinouranium, and hence in the older uraniferous minerals the radiogenic lead would have more of that isotope, specifically Pb (207).

Though for some time there has been fair agreement as to the rate at which actinium (which yields Pb 207) and radium (which yields Pb 206) were being formed at present, there has not been agreement as to the relative *amounts* of the isotopes and hence of the relative decay constants of UI and AcU.

Wilkins's point of view has been strongly supported by A. v. Grosse, who drew a curve connecting the age of a lead with the proportion of Pb (206) to Pb (207), and John L. Rose[3] estimated the proportions by strength of the spectral lines and also gave curves to estimate age. Dempster also made a preliminary estimate of the proportions of the uranium isotopes.

There has, however, been a uniformity in the atomic weight of radiogenic lead, not easy to explain,[4] and it has been not easy to tell how much ordinary lead might be mixed in.

Dr. Nier's success in recognizing the amount of ordinary lead by the amount of Pb 204 present, and in getting the various isotopes not only of lead but uranium with much greater accuracy than before and from much smaller quantities, ten milligrams or less, is a great step in advance and puts age determinations by lead on a sounder basis, and the variation of the proportions of isotopes in what has been supposed to be ordinary lead makes it not needful to suppose a common source for all of it. The identification of Pb (204) as characteristic of common lead enables one to allow for it.

The report of the committee on the measurement of geological time will not be out until next fall, I regret to say. Thus, I think this note of explanation desirable, so that the important work of Nier toward settling the important controversies started by v. Grosse and Holmes may not be minimized, and yet the fact recognized that it is supported by and a continuation of the pioneer work of Wilkins and others.

ALFRED C. LANE

JULY 11, 1938

[1] June 18, 1938, p. 392; SCIENCE, Supplement, p. 10, June 10, 1938.

[2] *Nature*, 117: 719–720, 1926; *Phys. Rev.* (2) 29: 352, 1927; *Bull. Geol. Soc.*, 38: 124, 1927.

[3] John L. Rose and R. K. Stranathan, "Geologic Time and Isotopic Composition of Radiogenic Lead," pp. 792–6 (1936), with references to previous work.

[4] A. Holmes, "Age of the Earth" (3rd ed.), pp. 151–153; *Ec. Geol.*, 32: 763–782, 1937.

AUTHORITY CITATIONS IN BIOLOGICAL NOMENCLATURE

THE protest[1] against dual authority citations as now prevalent in American botanical literature is well taken. Unfortunately the author raises the question, What authority should be used, the original describer of the species or the maker of the generic-specific combination? Generic-specific combinations change every twenty years. Zoologists have been using for decades, with apparent satisfaction, the original describer. Thus that system must be quite usable and is far more stable.

As a matter of fact, the majority of biologists have no use for the authority because the old original descriptions are extremely meager and lack comparative data. Manuals and recent monographs are used by the great majority of biologists. Only the highly specialized systematist consults the old original descriptions, and he does not need to know under what genus any one species originally appeared, as he has the page citation and the series number of the species in his catalogue. Moreover, one hundred years hence these ancient citations will no longer be consulted.

Many of the old authorities are of no practical importance; they are of historical interest. A real contribution to the advancement of nomenclature would be to discard the original authority and supplant it by reference to the best description, including the best set of figures—which would usually be the latest family or generic monograph of the species in question. In such a monograph the historically minded biologist would find all necessary references to the original and primitive descriptions.

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[1] SCIENCE, 88: 128, August 5, 1938.

SPECIAL ARTICLES

INDUCTION BY FAST NEUTRONS OF MUTATIONS IN ANTIRRHINUM AND MYOSOTIS[1]

In a recent paper[2] the author has shown that variations in germination as well as in the external morphology of some plants result from bombarding dry seeds with fast neutrons. It is now possible to record changes in flower color and flower form observed in the same plants.

To recapitulate briefly: seeds of six different genera with very small seeds were put into gelatin capsules, the latter were placed in turn in a lead box ($8 \times 8 \times 6$ cm) whose centimeter thick walls were lined inside with a 2 mm layer of paraffin. The box and its contents were laid on a metal shelf attached to the outside of the cyclotron "tank" so as to be close to the bombarding chamber, but at a distance of about 60 cm from the target. In this way the seeds could absorb only stray emanations from the cyclotron, whenever it was in operation, during the three months in which these experiments were conducted.

The most conspicuous results with respect to changes in flower color and flower morphology were seen in the cultures of *Antirrhinum* and *Myosotis*. The former showed more marked color changes, whereas in the latter morphological variations were more frequently found.

The seeds from which the *Antirrhinum* and *Myosotis* cultures were grown were exposed to the stray neutrons during part of the time through a period of six weeks. Other seeds in the same experiments (1) were subjected to the bombardment for periods ranging from one to nine weeks. In the case of the snapdragon cultures, controls and treated seeds were grown from the same seed capsule.

Myosotis flowers showed conspicuous alterations in their morphology. The various deformations and anomalies were as follows:

(1) Twisted petals
(2) Cleft petals
(3) Fused petals
(4) Increase in number of petals
(5) Decrease in number of petals
(6) Different-sized petals
(7) Decrease in number of sepals

The anomalies were often separate on different flowers or occurred in combination with one another, for example, (1) 8 petals, fused at the base, some of which were small and others very large; (2) 5 petals fused, 3 sepals; (3) 5 petals and 4 sepals; (4) 2 large, separate petals, 2 fused, and 3 sepals; or (5) 3 petals and 3 sepals.

"A Dictionary of Color"[3] was used to identify the flower colors and to record them for future reference. Colors given in parentheses indicate the names which the author used for identification in the greenhouse as they were often more descriptive than those given in the dictionary.

Variations in floral color in *Myosotis* were not marked, although in two plants there were "orchid" (pinkish-purple) flowers.

Three groups of *Antirrhinum* were grown from treated seed, and there were controls for each set as well. For Culture 1 the normal color was yellow L1 plate 10 (lemon yellow), for Culture 2 cerise (rose pink) and for Culture 3 was burnt orange (orange bronze).

In Culture 1 there were no observable differences from the controls except that the individual blossoms were slightly reduced in size.

The greatest color variations from the normal controls were found in Culture 2 and these variations with the percentage of plants having these differences were as follows:

(1) cerise (rose pink)—normal color	48.2	per cent.
(2) pink "5T" (light pink)	5.5	" "
(3) pink "1T" (pink white)	.8	" "
(4) magenta (lavender)	1.6	" "
(5) burnt orange (orange bronze)	34.7	" "
(6) bittersweet (light bronze)	9.2	" "

Of the total it is seen that 54.5 per cent. of the plants were either like the normal (cerise) or but slightly different from it (pink "5T" and pink "1T"), 43.9 per cent. were bronze-like, and only 1.6 per cent. were lavender. With the exception of the lavender flowers, which were smaller, the blossoms of this culture were about equal in size with the controls.

Culture 3 likewise showed marked variations from the normal color. The variants and the percentage of plants in the culture which were normal and which were different from the control are indicated as follows:

(1) burnt orange (orange bronze)—normal color	54.1	per cent.
(2) bittersweet (light bronze)	29.1	" "
(3) yellow L1 plate 10 (canary yellow)	4.1	" "
(4) spinel rose (pink)	12.7	" "

[1] Papers from the Department of Botany of the University of Michigan, No. 663.
[2] R. M. Chatters, SCIENCE, 87: 262–263, 1938.
[3] A. Maerz and P. M. Rea, "Dictionary of Color," McGraw-Hill Company, New York, 1930.

Here again the majority of the plants were like the controls in flower color (orange bronze) or a slight variation from it (light bronze).

Colored photographs of the floral variants and their controls have been made on "Kodachrom" film by Mr. Ralph Bennett, of the University of Michigan Department of Botany. Solutions containing the pigments from the flowers of the *Antirrhinum* cultures have been photographed in color by Dr. O. L. Inman, of the C. F. Kettering Foundation at Antioch College.

Seeds from a number of the anomalous plants have been collected and will be sown to obtain further data on the genetical effects of the bombardments on dry seeds.

All exposures were made with the University of Michigan cyclotron, which is supported by the Horace H. and Mary A. Rackham fund. The author wishes again to thank Professor J. M. Cork and Dr. R. L. Thornton for their assistance.

Summarizing: Some plants grown from dry seeds which had been exposed to stray neutrons from the cyclotron have given rise to flowers which are different in color and in morphology from their controls. It is hoped that the genetic relations of the new types may be determined through further experimentation.

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REVERSIBLE INACTIVATION OF PHOSPHATASE

A STUDY has been made of the effect of various oxidation and reduction systems on the activity of the enzyme phosphatase. It has been found that the activity of a potent enzyme preparation can be decreased to one tenth its initial value by reduction with hydrogen, using platinized or palladized asbestos as catalyst. The activity of the enzyme can be completely restored to its initial value by molecular oxygen in the presence of the same catalyst. The original enzyme preparation is as active in nitrogen as in air or oxygen, showing that oxygen is not essential for the activity of the enzyme. Treatment of the original enzyme preparation with oxygen in the presence of platinized asbestos was also without significant effect.

The enzyme, inactivated by hydrogen and the catalyst, remained inactive when the hydrogen was replaced by nitrogen, showing that the reduced enzyme, and not the hydrogen, was responsible for the inactivity.

Although it was found possible to inactivate the enzyme by reducing agents other than hydrogen, reactivation of the enzyme in these cases by oxidizing agents has not been achieved. Reducing agents, such as cysteine, cyanide and ascorbic acid, inhibited the activity of the enzyme in the order named. The inhibiting action of ascorbic acid was slight and detectable only in concentrations above 0.01 molar. The effect of various reversible dyes on the activity of the enzyme was studied. Anthraquinone β-sulfonate, phenosafranine, indigo-tetrasulfonate and methylene blue were without effect in their oxidized states. In their reduced states, however, they caused irreversible inactivation of the enzyme, the degree of inactivation depending upon the oxidation-reduction potential of the dye. The more negative the E'_0 of the dye, the greater was its inhibiting effect. The semiquinones of anthraquinone β-sulfonate and phenosafranine were slightly less active than the completely reduced dyes.

The phosphatase was prepared from beef kidneys by autolysis and repeated fractional precipitation, modified after the method of Albers. The enzyme exerted its greatest activity at pH 9.2. Though the enzyme preparations were of high activity, they were by no means pure. Tested by electrophoresis in the Tiselius apparatus,[1] the most active preparations contained at least three demonstrable protein components. The isoelectric point of the active component, measured in acetate buffer, ionic strength = 0.10, at 1° C., was pH 4.5 ± 0.1.

The experiments reported herein were carried out at 35° C. and pH 9.0 using glycine or veronal as buffer. β-glycerophosphate was used as substrate. $MgSO_4$, in a final concentration of 0.0007 molar, was present in all experiments. Phosphates were usually determined colorimetrically by the method of Fiske and SubbaRow, and also, in some cases, gravimetrically by the method of von Lorenz.

The protocol of a typical experiment demonstrating the reversible inactivation with hydrogen and oxygen follows:

0.05 mg enzyme in 30 cc solution
Substrate: glycerophosphate, 0.003 molar
Buffer: glycocoll, 0.017 molar, pH 9.0
$MgSO_4$: 0.0007 molar
Pt-asbestos present as catalyst

	Initial treatment 20 min.	Subsequent treatment 15 min.	Inorganic P released in 10 min. at 35° mg
(1)	..	..	0.765
(2)	N_2	N_2	0.755
(3)	O_2	N_2	0.780
(4)	H_2	N_2	0.105
(5)	H_2	O_2	0.740

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[1] The use of the Tiselius apparatus was made possible through the kindness of Dr. Ronald Ferry.

THE ISOLATION OF A CRYSTALLINE COMPOUND WITH VITAMIN K ACTIVITY

AN oil, very active in Vitamin K properties, has been obtained by the fractionation of a petroleum ether extract of alfalfa leaf meal. This oil, containing crystals in suspension, was dissolved in a mixture of benzene and absolute alcohol and allowed to stand at −5° C. The crystalline material which separated was recrystallized from a mixture of benzene and absolute alcohol, then from absolute alcohol, then from acetone and finally from absolute alcohol. The crystals, M.P. 69° C., were small, well-formed, transparent, colorless plates. The chick unit as determined by the procedure developed in this laboratory[1] is approximately 0.6 microgram.

Although it is possible that the activity of these crystals may be due to (1) formation of mixed crystals of the vitamin and an inert substance or (2) adsorption of the vitamin on the crystals, we believe that the crystals are really Vitamin K for the following reasons. These crystals have a greater potency than any other fraction that we have obtained, including the oil from which the crystals were separated. Moreover, the crystals were recrystallized from a variety of solvents without loss of potency.

We have also obtained certain indications that more than one substance possessing Vitamin K activity may be present in our extracts.

Our work is being continued, and the detailed data will be published in a subsequent contribution.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

CENTRIFUGING OF LIQUIDS

IN a previous article[1] a tubular vacuum-type centrifuge was described which has proven to be a very useful tool for the separation of comparatively large quantities of substances. Hence it may be of interest to mention briefly a rather simple change in the design of the spinning tube which has considerably increased its efficiency. The apparatus consists of a tube that is spun to a high rotational speed inside an evacuated chamber. The vacuum around the rotor avoids heating due to air friction and insures absence of troublesome temperature gradients that cause stirring. Fig. 1a shows a schematic diagram of the tubular rotor. For the method of mounting and spinning this rotor, reference should be made to the previous article.[1] The material to be centrifuged entered the spinning hollow tube at A at a continuous rate and the lighter and heavier fractions were collected at C and B, respectively. The separation took place as the material flowed down the length L of the spinning tube. It can easily be seen that for a given material and rotational speed the amount of separation increases with increasing radius of the tube, increasing L, and decreasing rate of flow of the material; *i.e.*, the radius of the tube and the time the material is in the centrifuge. By definition[2] of the sedimentation constant s, the rate of settling of the heavier substance toward the periphery $\frac{dx}{dt} = w^2sx$ where w is the angular velocity of the centrifuge and x the distance of the material from the axis of the tube. Hence $\frac{dx}{dt} = o$ when $x = o$, and in the absence of diffusion the separation would be very small near

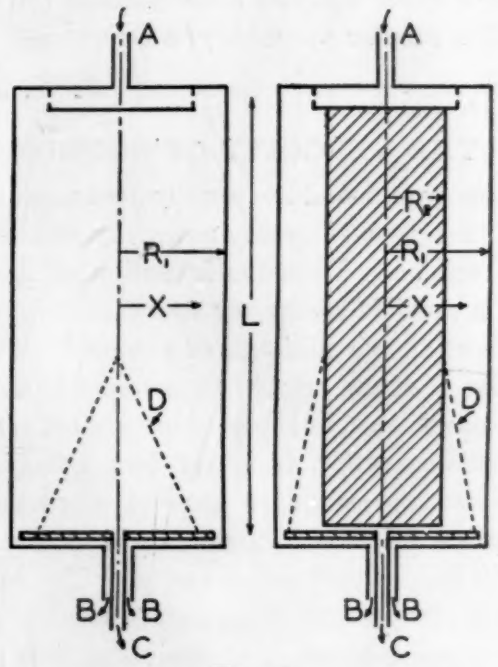

FIG. 1

the center. To overcome this we have been using for some time a solid cylinder in the center of the tube as shown shaded in Fig. 1b. R_1–R_2 is made comparatively small and D is a wire cloth filter to prevent possible remixing at the exits. With this arrangement the material is always in a strong centrifugal field and the

[1] S. A. Thayer, D. W. MacCorquodale, R. W. McKee and E. A. Doisy, *Jour. Biol. Chem.*, 123: exx, 1938.
[1] Beams, Linke and Skarstrom, SCIENCE, 86: 293, 1937; Beams, *Phys. Rev.*, 53: 850, 1938.
[2] Svedberg, "Colloid Chemistry."

separation is much faster. The volume of the centrifuge is, of course, decreased, which decreases the time that the material is in the centrifuge, but a simple calculation shows that this decrease in time is much more than compensated for by the increase of the average centrifugal field. Experimental tests also show a large increase in efficiency.

In addition to the purification of materials by the continuous flow vacuum-type tubular centrifuge, it is possible at the same time to determine the sedimentation constant s from a knowledge of the dimensions of the centrifuge, rate of flow of material, the ratio of the amounts of the light and heavy fractions and the ratio of the concentrations of the original material and the light and heavy fractions. From a knowledge of s and the diffusion constant, the molecular weight may be obtained.[2] As yet extremely high accuracy has not been obtained, but the results are reproducible with precision. Since the molecular weights of substances from about 40 up to 20,000,000 have previously been measured with precision principally by Svedberg and his collaborators,[3] these materials with known molecular weights can be used to calibrate a particular vacuum-type tubular centrifuge. After once calibrated, the apparatus should give comparatively precise results, especially for high molecular weight substances.

It is a pleasure to record my indebtedness to the Division of Natural Sciences of the Rockefeller Foundation for a grant that has made possible the development of the tubular vacuum-type centrifuge.

J. W. BEAMS

THE VELOCITY OF SOUND

THE velocity of sound has usually been measured over long distances (one to twenty miles) by means of guns and stop watches. With the invention of the oscilloscope, it is possible accurately to measure intervals of time as short as one millionth of a second. Therefore, the velocity of sound may be measured with a baseline less than one foot. As a base line so short can not be determined accurately, a longer base line should be used. Since the standard current alternates sixty times per second, one complete cycle of the current represents one sixtieth of a second. The horizontal plates of a standard oscilloscope are connected to the alternating current, which at the same time causes a loud speaker to emit sixty pulses per second. These sound pulses are received on a microphone which is connected through an amplifier to the vertical deflection plates of the same oscilloscope. The electric impulses received by all four plates must be in synchronism; hence a single line appears on the oscilloscopic screen. If the microphone is moved through approximately twenty feet, the line on the oscilloscope will move through one cycle or one sixtieth of a second. The product of 20 and 60 gives 1,200 feet for the velocity. Careful measurements give the actual velocity 331.57 meters per second at 0° C.

This method may be improved by receiving the impulses alternately upon two microphones through the use of a double pole switch. This obviates the necessity of moving a single microphone twenty feet for each observation.

Accurate measurements can be made over shorter distances by using a continuous sound source instead of a succession of impulses. The sound received in the microphone then sets up a series of sinusoidal waves upon the oscilloscope screen. The microphone is moved until one wave passes across the reference line. In this way both the wave-length and the velocity are determined at the same time.

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